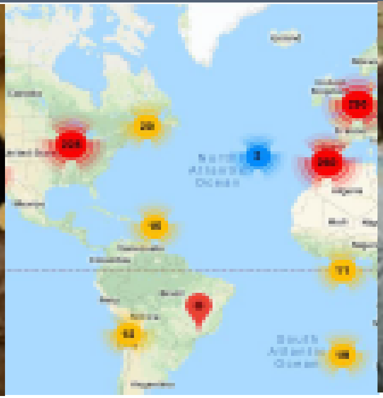
Energy Storage Demonstration Projects –

OE-ES Peer Review

Project: 2170654: Energy Storage Control for Maximum Remote Alaskan Microgrid Benefit

10/26/21



PRESENTED BY

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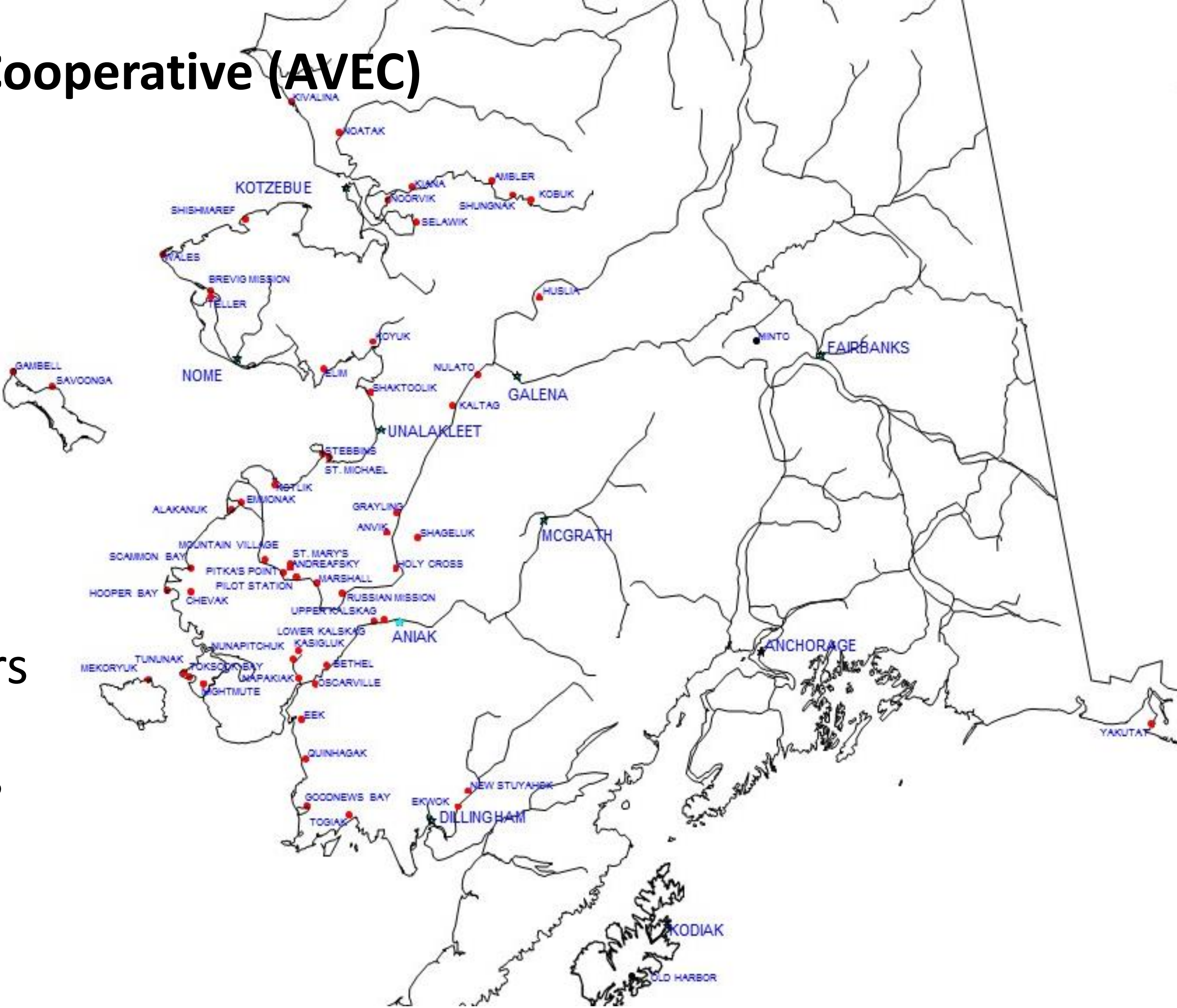
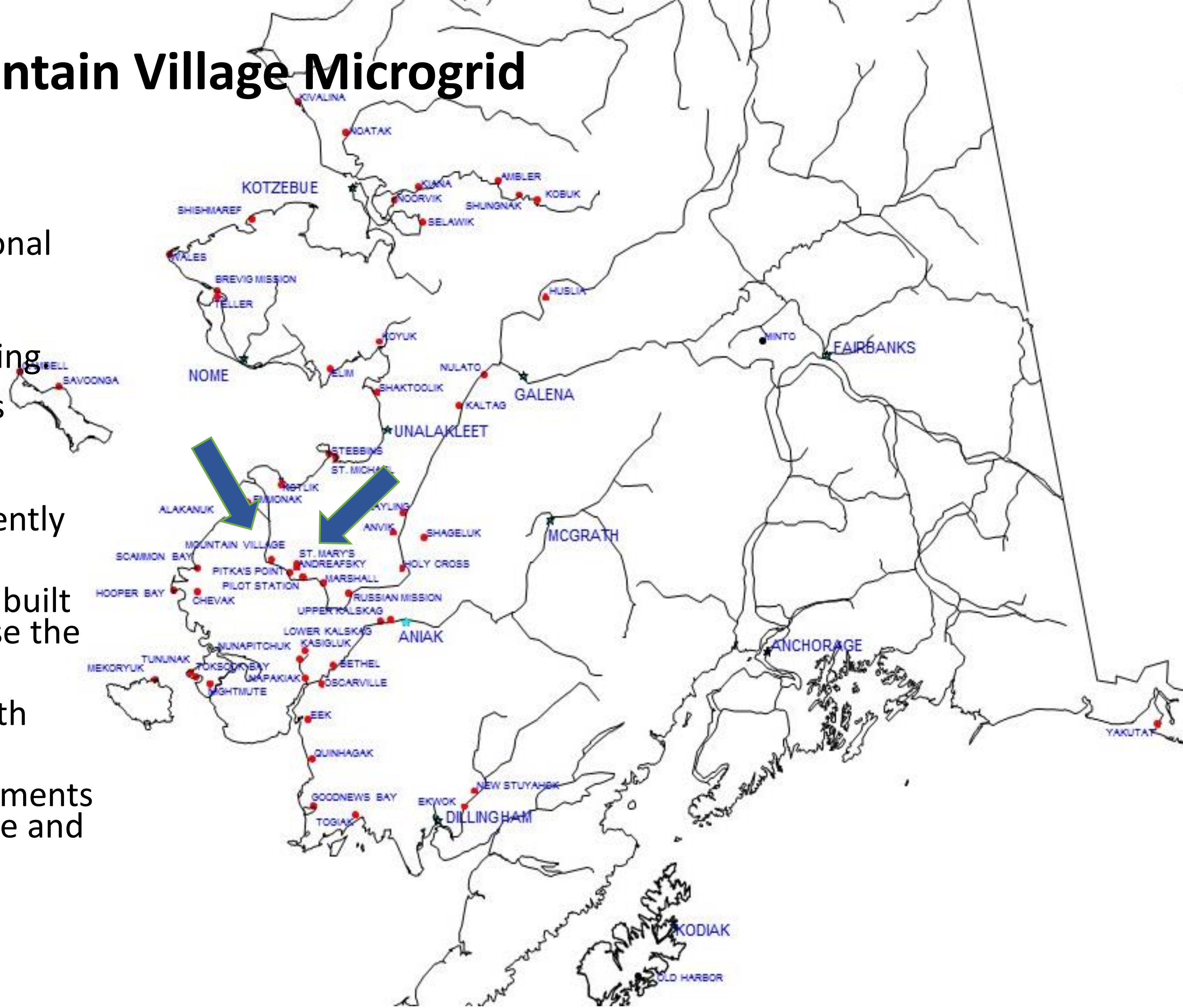
Alaska Village Electric Cooperative (AVEC)

- Member-owned rural electric cooperative
- 58 microgrid communities across Alaska served
- 50 power plants
- 12 wind-diesel hybrid systems serving 19 villages
- 170+ diesel generators 100kW to 2.2MW
- Average Village Loads 46kW to 4.8MW

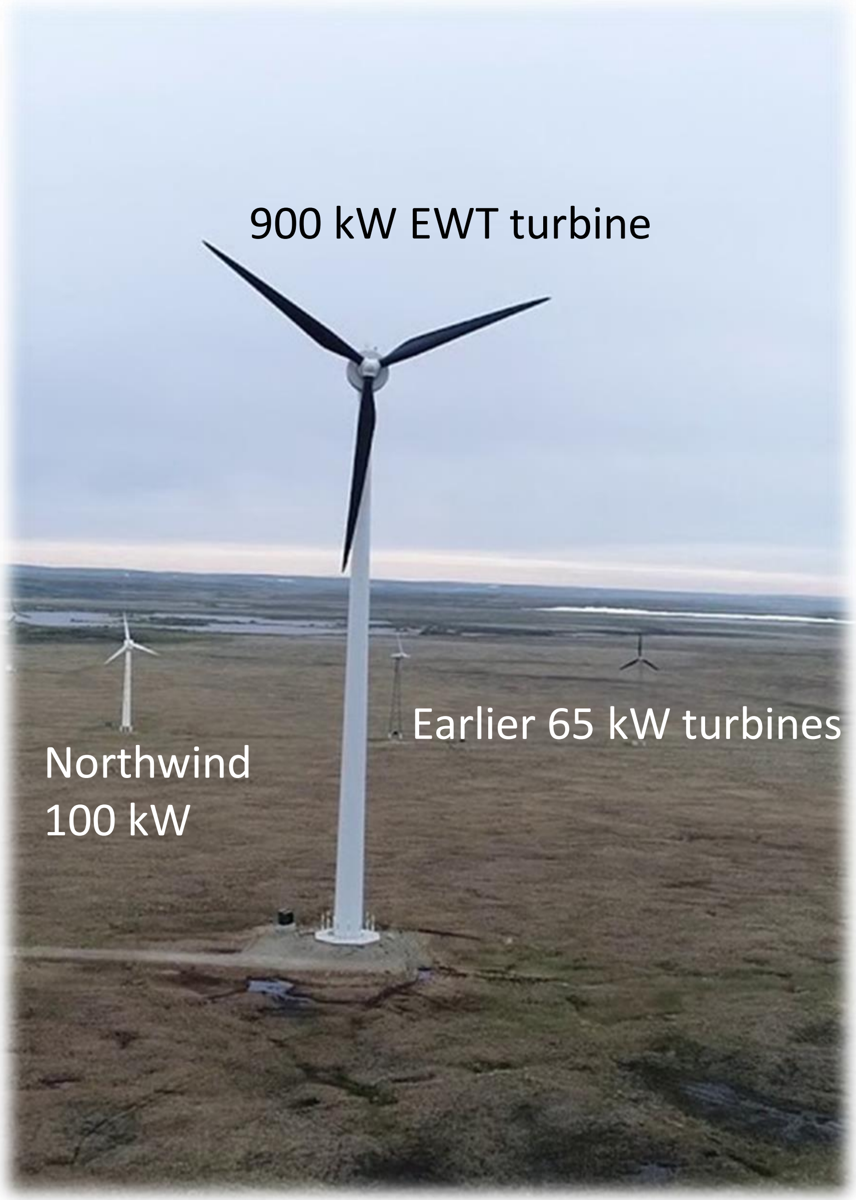


The Saint Marys – Mountain Village Microgrid

- +90% Yup'ik Inuit/Eskimo Communities
- Low family incomes and Traditional Subsistence Practices
- Extreme Isolation and difficult logistics create a high cost of living.
- Including Electricity, which costs about 50 cents per kWh before subsidies.
- A 900 kW wind turbine was recently installed near St Marys.
- A 25 mile transmission line was built to Mountain Village to better use the turbine output.
- Peak load is about 1 MW for both communities.
- Poor or non-existent fire departments and health care requires that fire and personnel safety be a primary concern.



- AVEC has discovered that larger turbines, for instance the EWT 900 kW model, even when larger than the size of the microgrid that they are attached to but are well behaved and leapfrog us into high penetration very quickly.
- Unfortunately, the unpredictable nature of wind requires that we provide essentially 100% spinning reserve for the turbine, forcing us to run a large diesel with light load whenever the wind is blowing.
- An Energy Storage System can be configured to behave as a Grid Bridging System (GBS). The primary purpose of a GBS is to provide synthetic spinning reserve, allowing either a smaller diesel to be run, or even diesels-off operation.



AVEC Grid Bridge Project

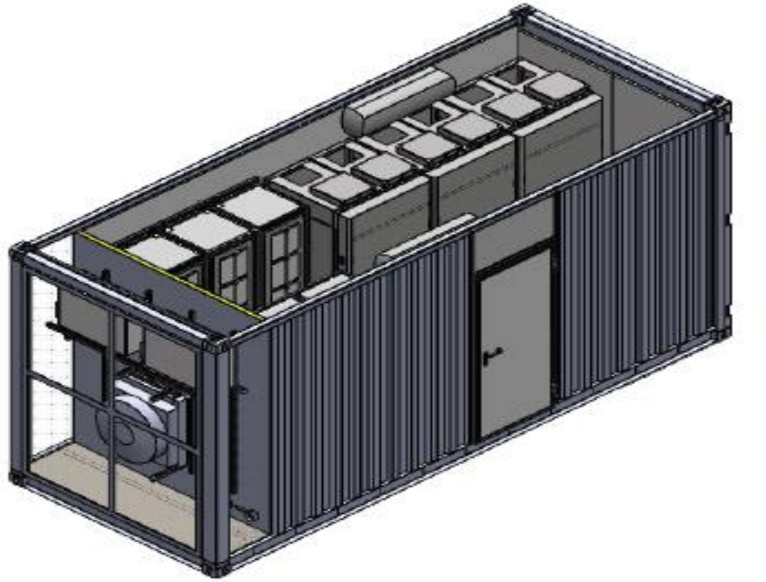
A GBS only requires perhaps 10 minutes of storage, which could be provided by Lithium Titanate batters or even Ultracapacitors.

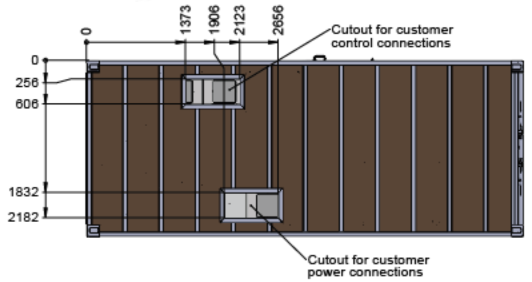
In order to survey the state of the art, we asked for 10 minutes, 1 hour and 4 hours of storage based on 1 MW capacity.

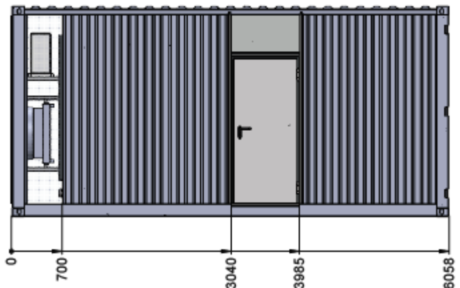
We decided to not purchase the short term 10 minute storage option (even though it had the best pay-back), nor did we purchase the long term 4 hour option, but rather the mainstream 60 minute storage option.

We felt as a demonstration project, having 60 minutes of storage rather than 10 minutes would allow us to research a greater variety of operating paradigms.

The four-hour storage option could not be justified economically. Opportunities to shift energy from surplus times to higher cost sources did not justify the extra expense. We believe that is common for wind-diesel microgrids.







AVEC Grid Bridge Project

Past Dates:

January 2021: the last required funding was obtained from Sandia allowing us to proceed.

February 2021: the RFP was reviewed and updated. The original RFP was by then 2 years out of date in this fast moving field.

March 3rd 2021: The new RFP was released to the street, the original closing date was March 25th 2021.

Because of vendor requests for more time we modified the closing date to April 1st 2021.

April 2021: Selection of Vendor, completion of essential project design

May 2021: Award to winning Vendor

June 2021: Approval Drawings received.

July 2021: Approval of drawings and start of construction

Pending Dates:

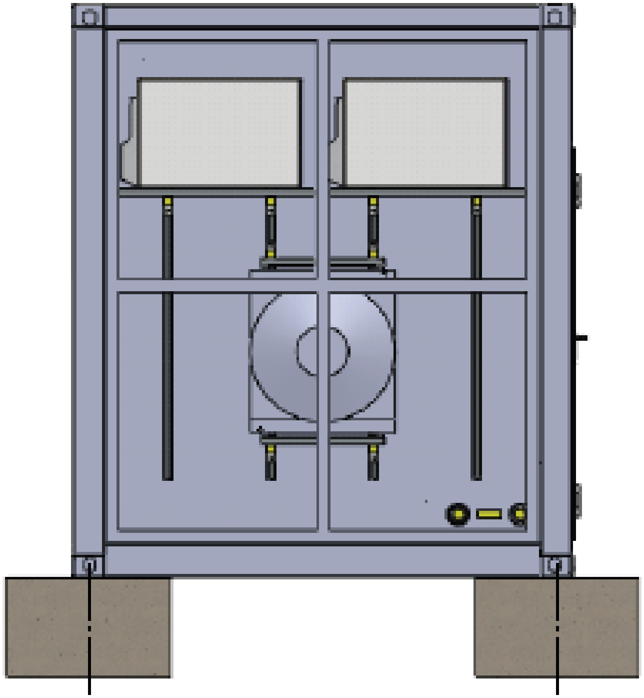
February 2021-March 2022: Testing and validation by the Alaska Center for Energy and Power in Fairbanks.

March – June 2022: Shipping to St Mary's Village from Fairbanks

June 2022: St Mary's infrastructure completed

July 2022: System on Site

August 2022: System Installed, Commissioned, turned over and put in operation.



AVEC Grid Bridge Project

Benefit Streams:

- Removing the need to keep diesel spinning reserve, especially the large requirements to cover wind generation, allows engine selection based on best fuel efficiency (smaller or no engines).
- The amount of engine switching is reduced by charging or discharging the battery, until the trend up or down is proven.
- Power reliability is greatly improved as the GBS provides unit plus one redundancy to cover the loss of diesel generators, not just the wind turbine.
- If the GBS is tuned to respond quickly, diesel efficiency is improved due to slower load changes.
- System frequency and voltage stability is expected to improve.
- Some energy can be stored during high wind and retrieved to offset diesel generation at another time.

AVEC Grid Bridge Project

AVEC will be providing an in-house System controller

Using the following MicroGrid Control Methodology:

- The System Controller provides the diesel plant with the calculated amount of available spinning reserve. The diesel engine controller takes that into account when deciding to change engines, or go diesels off.
- The GBS internal frequency loop will have a fast preset frequency droop with load. The System Controller adjusts the frequency setpoint to the GBS every 100 to 1000 mseconds to adjust desired GBS power flow and maintain system timekeeping.
- In case of a instantaneous loss of generation and a subsequent drop in frequency, the GBS will make up the missing generation linearly as the frequency drops until a balance is obtained.
- The System Controller will return system frequency to normal using the GBS while simultaneously asking for additional diesel generation.

- The System Controller is provided the following information from the diesel power plant controller.
  1. Current Real Time Diesel Loading.
  2. Minimum desired Diesel Loading with the currently on-line engines. The GBS will charge to keep above this level if possible, if not, wind will be curtailed or a secondary load turned on. Both of these are also controlled by the System Controller.
  3. Maximum desired Diesel Loading. The GBS will discharge if necessary to keep diesel loading below the maximum, until conditions warrant changing to a bigger engine.
  4. In between max and min, the system controller ensures that the GBS runs at null power output, or at a minimal rate of charging if it below desired state of charge.

AVEC Grid Bridge Project

Total Estimated cost:	$1,550,000
DOE Cost share for soft costs:	$ 700,000
Partner Cost:	$ 850,000

Our testing partner: Alaska Center for Energy and Power in Fairbanks Alaska

Thank You

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This work is funded by the DOE OE Stationary Energy Storage program directed by Dr. Imre Gyuk.